large concave grating is also being used in an investigation of arc and spark spectra, in comparison with the solar spectrum.

If any members of the A. S. P. happen to be in Chicago, I shall be pleased to welcome them to our observatory if they care to visit it.

CHICAGO, November 4, 1890.

THE LAW OF THE SOLAR CORONA.

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In compliance with a request from Professor HOLDEN, I send a brief summary of results of some studies on the Solar Corona, referring the Society to the paper published in the Amer. Journ. Sci., Nov., 1890, for the mathematical details. This computation refers to the La Junta photograph of July 29, 1878, but similar calculations are sufficiently advanced on the coronas of 1889 to state that they all seem to conform to the same analysis, and that the same equation is applicable to each.

The Newtonian law of the potential in its inverse action, when applied to a polarized sphere, is laid at the basis of the work, and as its proof by several methods is given in connection with its use in electricity and magnetism, we are now concerned only in the identification of the direction of the coronal streamers with the lines of force produced under these conditions. The repulsion of the surfaces of infinitesimally small particles, obeying this law, is all that is required as a fundamental conception, by way of a physical interpretation of the facts themselves.

The formula must also take account of the distortion of the rays which spring up from the sun at any part of its surface, so far as may be assumed, but are seen from the earth as if projected on the plane through the centre of the sun, perpendicular to the line of sight. Also the coronal poles may not be taken as coinciding with any line of the above plane of the disk, but we do see the plane in which they lie perpendicular to the disk, and must compute the angular distance from the disk to the coronal pole. The poles of the sun's axis of rotation, of the plane of the Ecliptic, and the plane of the equator at the centre of the sun being given, we may, from their projections on the disk, find the heliographic longitude and latitude of the coronal poles at the time of the eclipse.

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The photographs were measured on the Stackpole Transit of Venus Engine. The plane of the coronal pole is selected by inspection of the general symmetry of the rays; on a given ray the polar co-ordinates are measured off for at least three points. This gives $(\gamma_1\ \theta_1)$ for the first point. Substituting in the formula $N = \frac{8\pi}{3} \cdot \frac{\sin^2\theta}{\gamma}$, if the points all lay on a ray seen without change by projection, the values of N should be the same, and this is the order of the ray. These values of $\gamma.\ \theta.$ do not give the same N, because a ray seen in its projected position lies across several N's, and we therefore compute a series of orders of rays.

If α is the angle at the disk through which a plane must be turned to change from the disk to the plane of a coronal ray, we find

$$\sec^2\alpha = \frac{X_2^{\frac{4}{3}} Y_1^2 - X_1^{\frac{4}{3}} Y_2^2}{X_1^{\frac{4}{3}} X_2^2 - X_2^{\frac{4}{3}} X_1^2} \text{ where,}$$

$X_1 = \gamma_1 \sin\theta_1$, $Y_1 = \gamma_1 \cos\theta_1$, the successive measured points having appropriate suffixes. If the pole of the corona coincided with the axis of rotation of the plane the values of α should agree, but they also form a series from which it is easy to interpolate the proper one, the choice being finally checked by the resulting values of the angle at the base of the ray on the sun.

The formula for N now becomes $N = \frac{8\pi}{3} \cdot \frac{X_1^2 \sec^2\alpha}{(X_1^2 \sec^2\alpha + Y_1^2)^{\frac{3}{2}}}$, and after the introduction of the angle α the ranging of the N's has ceased.

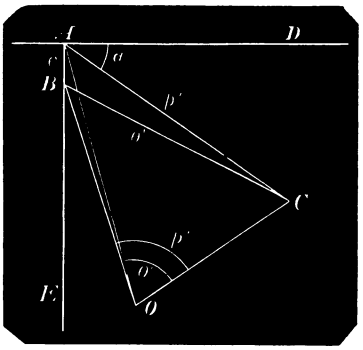
Having thus obtained the order of the ray, we pass along the ray to the surface of the sun by taking $\gamma = 1$, and compute the angle θ by $\sin^2\theta = \frac{3}{8\pi} N$.

The peculiarity discovered by this equation is that all the rays of the corona are confined to a belt between 28° and 40° polar distance for each hemisphere, counted from the coronal pole, the maximum number being along the parallel of 33° or 34°, thus furnishing an analogy to the terrestrial aurora, if not its very progenitor.

Now taking
$$X_1 = \gamma_1 \sin\theta_1$$
$$Y_1 = \gamma_1 \cos\theta_1$$
$$Z_1 = X_1 \tan\alpha$$
$$D_1 = X_1 \sec\alpha \quad \text{we find,}$$

$$\tan p_1 = \tan \theta_1 \sec \alpha$$
$$\gamma_1 = X_1^2 \sec_2 \alpha + Y_1^2$$
$$\sin^2 \theta^1 = \frac{3\gamma}{8\pi}. \text{ N.}$$

γ_1 θ_1 are the measured values of the first point, α is the angle at the pole on the disk between the plane of the disk and the plane of the ray, p_1 is the angle at the center of the sun between the axis of the pole on the disk and the radius to the point before projection, γ_1 is the radius of this point, θ^1 is the angle at the center of the sun from the axis of the corona to this radius.



A E = direction of projection.

A = projection of coronal pole B on the plane of the disk A D.

C = point measured, seen in projection.

In the spherical triangle we have given θ^1, p^1, 90 — α, for each point discussed. The solution is, sin B = sin p^1 sin (90—α) cosec θ^1

$$\tan \tfrac{1}{2} c = \frac{\cos \tfrac{1}{2} (A + B)}{\cos \tfrac{1}{2} (A - B)} \tan \tfrac{1}{2} (\theta^1 + p^1).$$

This value c is the angular distance from the plane of the disk to the pole of the corona.

From these data we compute, by a rather complicated series of triangles, the latitude and longitude of the poles of the corona. The following tables give the collected results. It should be borne in mind that they were obtained for July 29, 1878, by measures on the La Junta Photograph, which shows the covering moon with a diameter of 0.362 inch, the available corona not extending over three-fourths of an inch. With large photographs very accurate readings can be made; the formulas are very sensitive to the effects of small changes in the angles.

Resulting Values of the Polar Distance of the Base of the Coronal Rays on the Sun from the Coronal Pole.

Ray.	S. W. Quad.	S. E. Quad.	N. E. Quad.	N. W. Quad.
	θ	θ	θ	θ
I	35 0	31 41	——	33 5
	31 41	33 25	30 48	30 17
	30 21	29 28	28 35	30 2
II	29 22	30 28	——	28 2
	31 23	32 34	28 32	27 41
	30 44	22 23	19 27	26 11
III	33 59	34 25	28 43	36 30
	32 26	34 59	32 55	34 5
	30 50	31 48	30 59	32 5
IV	30 16	33 45	31 8	34 52
	31 25	34 1	33 39	33 30
	30 14	31 38	30 32	32 26
V	33 51	34 1	32 41	34 24
	35 51	34 19	33 17	35 0
	33 20	33 25	31 32	34 23
VI	36 33	34 52	33 25	33 5
	36 35	34 54	33 18	31 29
	35 41	32 38	34 34	
VII	——	35 8	36 0	41 55
	38 59	35 13	36 23	41 58
	38 57	35 11	35 16	40 49
VIII	41 6	39 7	42 25	
	41 7	39 11	42 23	
	40 30	38 39	40 16	
		37 26		

Angular Co-ordinates of these Rays.

Ray.	S. W. Quad.		S. E. Quad.		N. E. Quad.		N. W. Quad.	
	α	θ	α	θ	α	θ	α	θ
	°	° ′	° ′	° ′	°	° ′	°	° ′
I	87	32 41	88 50	31 31	89	29 42	75	31 8
II	84	30 30	88 20	31 30	85	30 52	65	27 18
III	82	32 25	79	33 44	81	31 45	73	34 40
IV	78	30 38	71	33 8	75	32 50	68	33 26
V	75	34 21	66	33 55	64	33 46	59	33 37
VI	59	36 16	62	34 8	49	35 53	30	41 34
VII	48	38 58	42	35 11	24	41 41		
VIII	33	40 54	40	38 18				

Location of the Coronal Pole as determined from the several Rays.

Ray.	S. W. Quad.	S. E. Quad.	N. E. Quad.	N. W. Quad.
	c	c	c	c
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
I	2 51 18	1 37 56	1 35 0	2 24 2
II	1 58 4	0 0 0	1 20 14	−0 6 38
III	2 56 34	0 51 38	1 24 30	2 24 30
IV	2 45 20	0 49 34	1 5 16	4 2 34
V	1 12 16	0 54 26	−0 5 28	2 17 1
VI	1 8 56	0 58 48	1 8 58	1 0 32
VII	−0 23 42	2 51 32	2 46 18	
VIII	0 30 34	1 23 50		
	1 44 58	1 10 58	1 9 21	2 0 20

Mean for South Pole } 1° 27′ 58″. Mean for North Pole } 1° 34′ 51″.

Resulting Heliographic Co-ordinates.

	North Pole.	*South Pole.*
Longitude	66° 56′.2	168° 11′.1
Latitude.....	+85° 44′.6	80° 39′.5

Difference of Longitude, 101° 14′.9.

Difference in Longitude of the Poles of the Terrestrial Magnetism, 111° 51′.

It will be seen by computation that the extremities of the coronal rays are vertically above the sun spot belts at the Minimum of the Period.